The Internet of Things

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Agenda

- Introduction
- A vision of the Internet of Things
- Related Projects

The Internet of Things

Roadmap

No Animals Allowed!

"On the Internet, nobody knows you're a dog."

"On the Internet, nobody knows you're a light bulb."

Connectivity

1950

2000

2050

Source: Internet Zero, MIT

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Introduction

- Who am I?

  Dr. George Bilchev

  Head of Sensor Networks Research Group

  Pervasive ICT Centre

  Group CTO

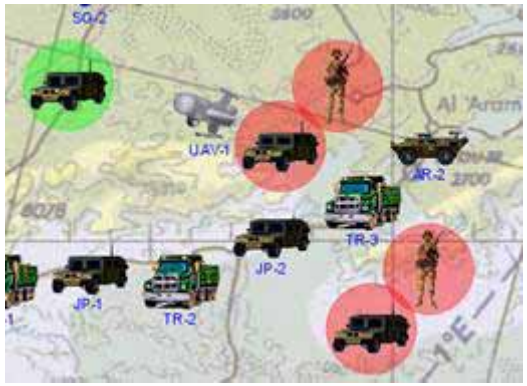
  BT

- What do we do?

  Research and innovation in the areas of Sensor Networks, M2M (machine-to-machine), pervasive information and pervasive computing

Research Context

- Ubiquitous Computing - Cheap, always-on technology to enhance people's lives and work
  - Environmental Monitoring
  - Telecare
  - Home Networking
  - Intelligent Buildings
  - Military operations
- State of art research, often in collaboration with top universities



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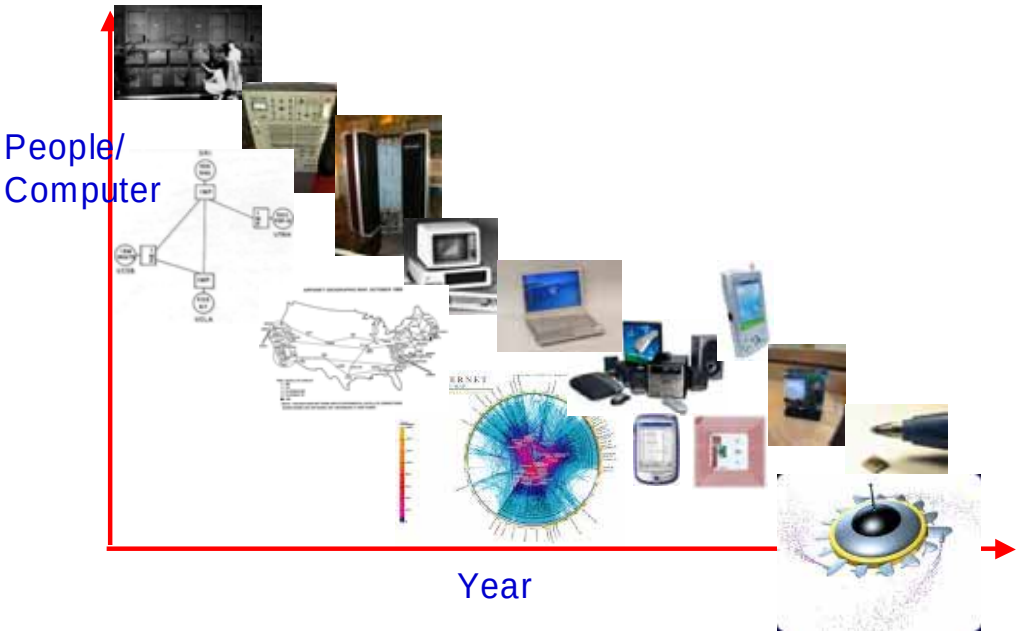
Evolution of the Species



From large mainframe… to personal computer…to pervasive computing... to the Internet of Things…

The world of the future will be a single pervasive network of heterogeneous elements.

Processes will arise in the network in response to the needs of people (individuals or groups).

The processes will run on a network of service-oriented capabilities.

The Vision

Fusion of the physical and digital worlds

- Physical entities have digital counterpart (i.e. digitised)
- Objects could sense, communicate & interact (i.e. context aware)
- Immediate responses to physical phenomena
- Instant information about physical entities
- Improve business insight & enable the real-time economy
- Enable intelligent real-time decision making

The Challenges

- Information Flow Management
  - Condense a massive amount of data into discrete pieces of information in a secure timely fashion through the right medium and appropriate granularity
  - Publish & subscribe
- Understanding & extracting value from reality online data
  - Context models
- Data quality & integrity
  - Uncertainty in data
  - Anomalous events
  - Confidence in information
- Naming, addressing & querying the physical world
  - Is the physical world IP centric

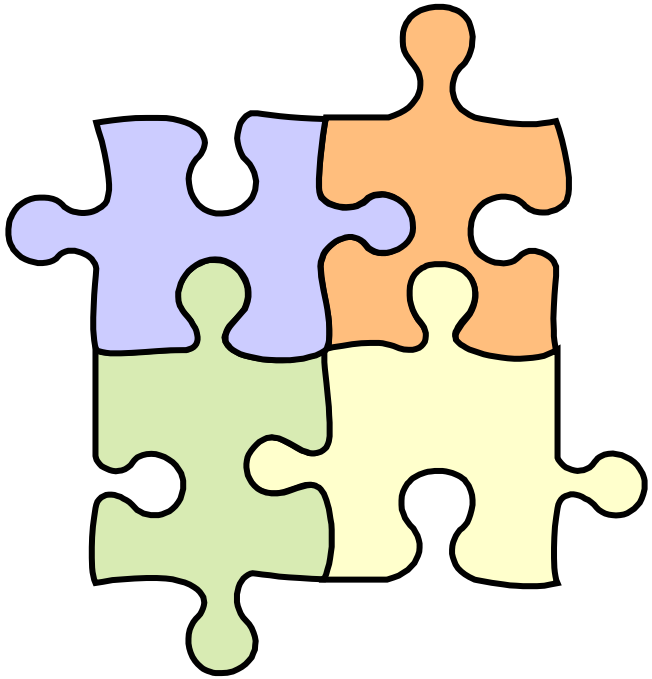
Security Challenges

- Evolution from large central systems (mainframes) to pervasive computing
  - Security enforcement & management can no longer be centralised
- Attacks growing in number and complexity
  - Highly interconnected non-linear systems have unexpected and unpredictable behaviour with unknown threat models
- Need to deal with attacks in a different way
  - Not cost effective to deploy traditional perimeter based solutions
  - Need to start to live with “permanently-ill” developed software
- Information underpinning the economy and society
  - System only as valuable as the information

Value to the world

- Immediate response to physical phenomena
  - Incidents
  - Business requirements (i.e. stock)
- Gain insights into complex processes and relationships
  - environmental (pollution, disaster, global warming)
  - human activities (work, criminal, health, military)
  - infrastructure integrity (civil, energy, water, transport)
- Enable adaptive business processes
  - No assumption/model about the physical world
- New services based on real-time physical world data
  - Whereness, LBS
- Breaking down the sectors
  - New applications enabled by the fusion of data from separate market sectors

Dependencies



- Commercial or regulatory drivers
- Adequate security
- Energy scavenging
- Sensor platform standards
- Robust encapsulation for diverse environments (zero touch installation)
- Large-scale manufacture

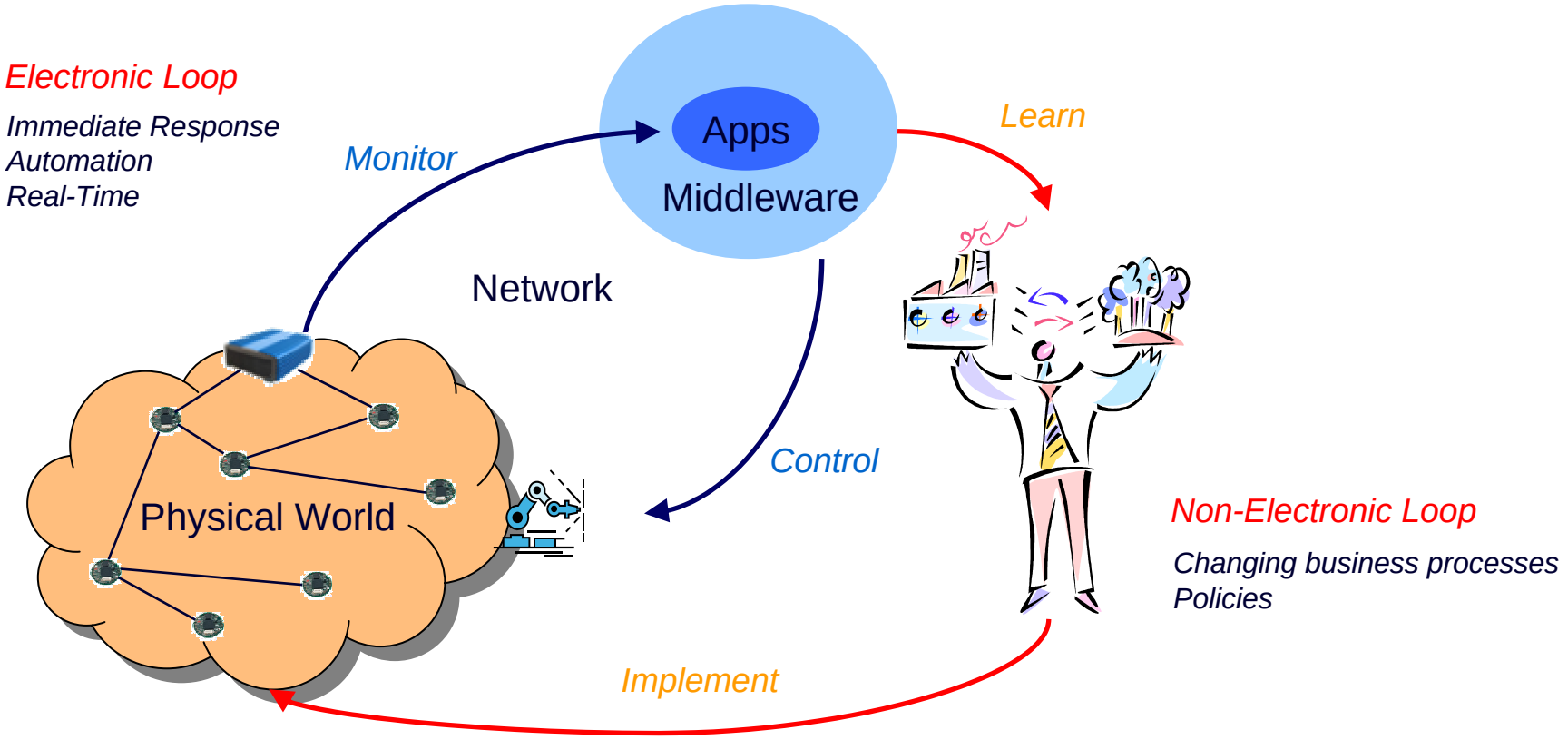
Object Hyperlinking

A killer app for the Internet of Things?

- Extend the Internet to objects and locations in the real world
  - a.k.a. WWW of things
- Attaching tags with URLs to tangible objects or locations
  - Siemens virtual tagging system - Digital Graffitti Service: Digital messages can be attached to pictures of a local sight to provide information about the building.
  - Semapedia (http://www.semapedia.org/) - the goal is to connect the virtual and physical world by bringing the best information from the internet to the relevant place in physical space.

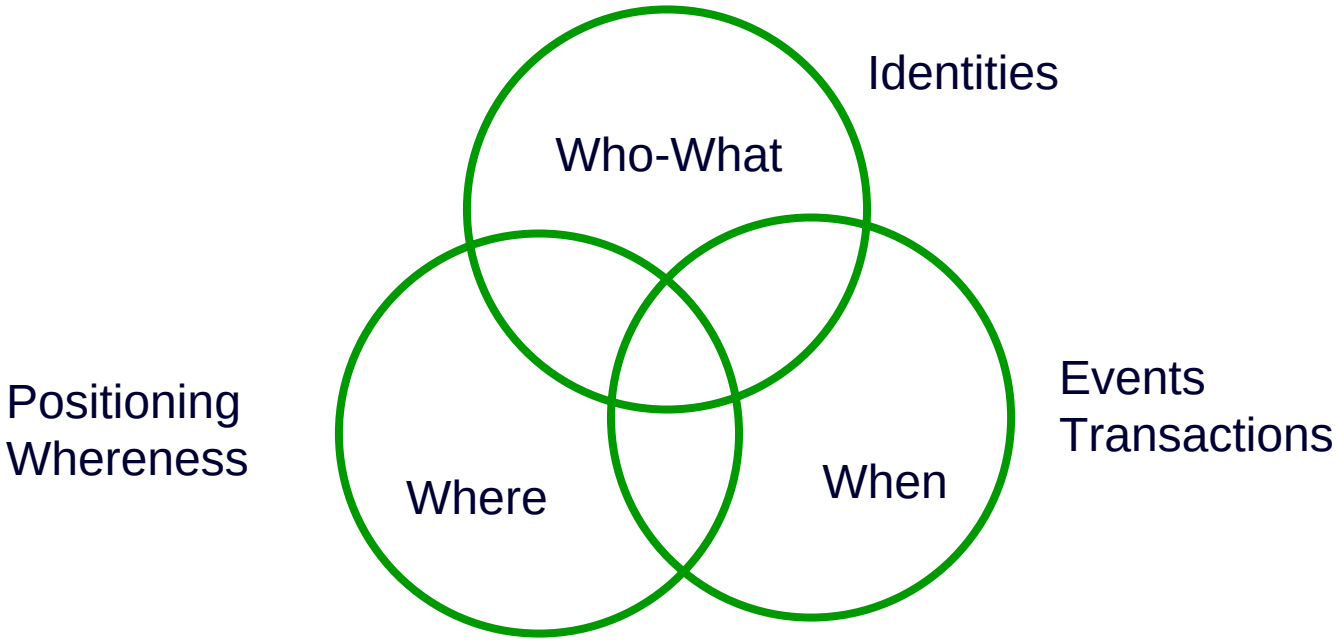
Real-Time Enterprises

A killer app for the Internet of Things?



From RFID to The Internet of Things

- Definition of the information space
  - Auto-ID/RFID – part of a wider space of “Who-What, Where & When”
  - Using semantic web approach



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Care in the Community

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Main aims

- Continuously monitor clients in their own setting, particularly those clients who are elderly and live alone
  - low cost
  - zero touch
  - autonomous sensors which can be readily deployed with minimal disruption
  - low power
  - wireless

Activities of Daily Living

- Bath/Shower
- Bed
- Chair/sitting
- Dressing
- Washing/grooming
- Managing medication
- Feeding (and drinking)
- Walking
- Stairs/steps
- Writing
- Toilet
- Handling money
- Telephone
- Opening front door
- Preparing hot food/drink
- Household tasks





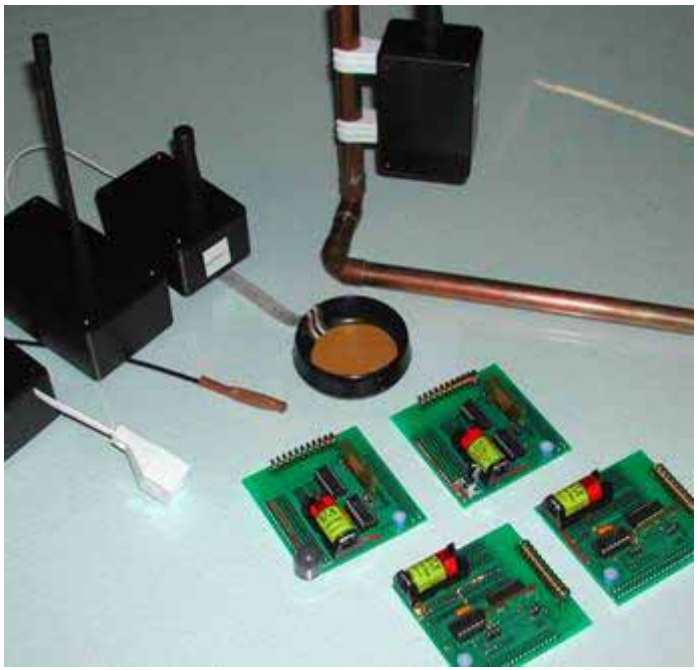
Cup of tea detector?

Location, water & power

Water flow detection

Range of sensors

- Vibration
  - **switch**
  - **bimorph**
- Pressure
- Telephone
  - **on/off hook**
- Power
- Cooking activity
- IR
- PIR
  - **room temperature**
- Water flow
  - **temperature**
  - **noise**



Traffimatics

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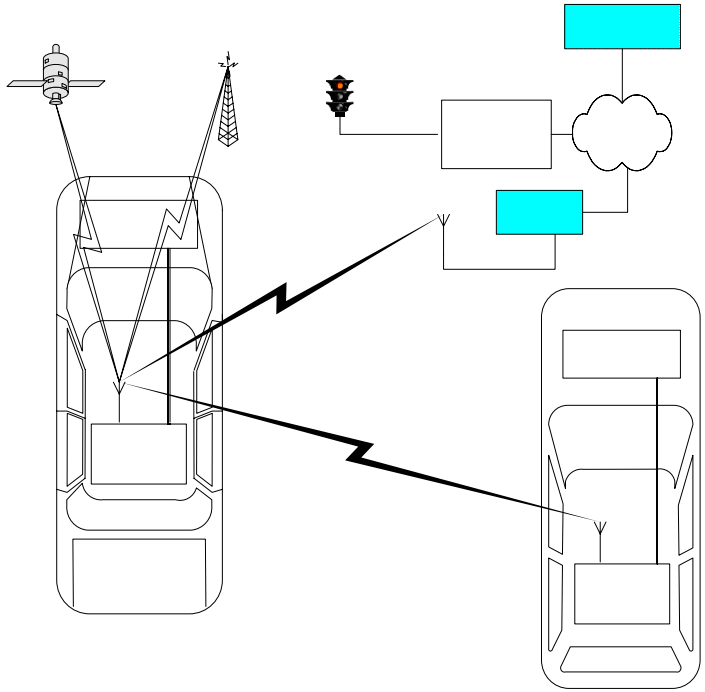
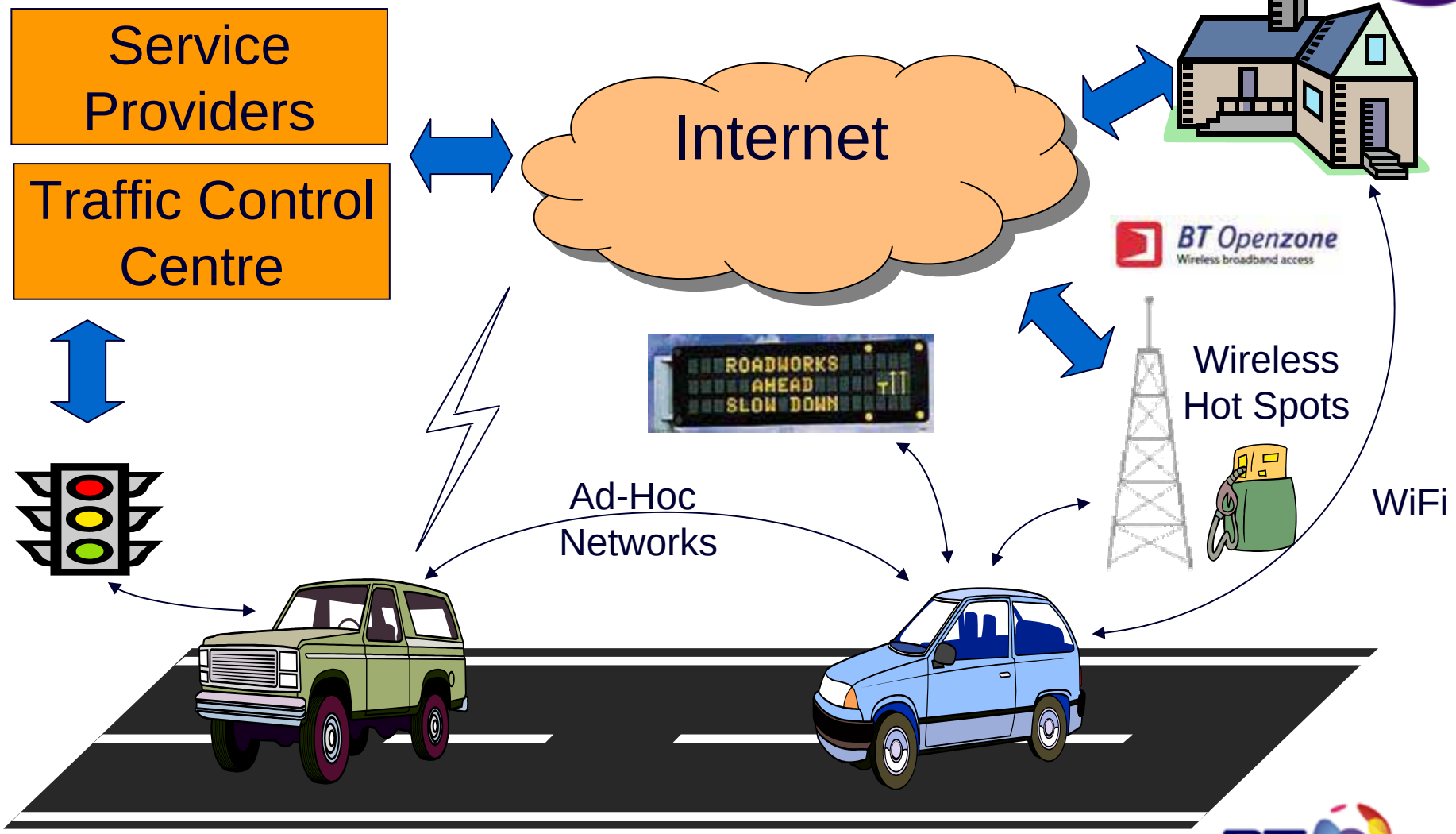
Traffimatics Concept

- Intercept vehicle status data via CAN bus.
- Analyse status with location context to deduce intentions or recognise problems.
- Communicate information and warnings to other road users and the infrastructure operators.
- Receive and analyse information: present relevant advice to the driver in a useful way.



Traffimatics Vision

The Connected Car



SECOAS

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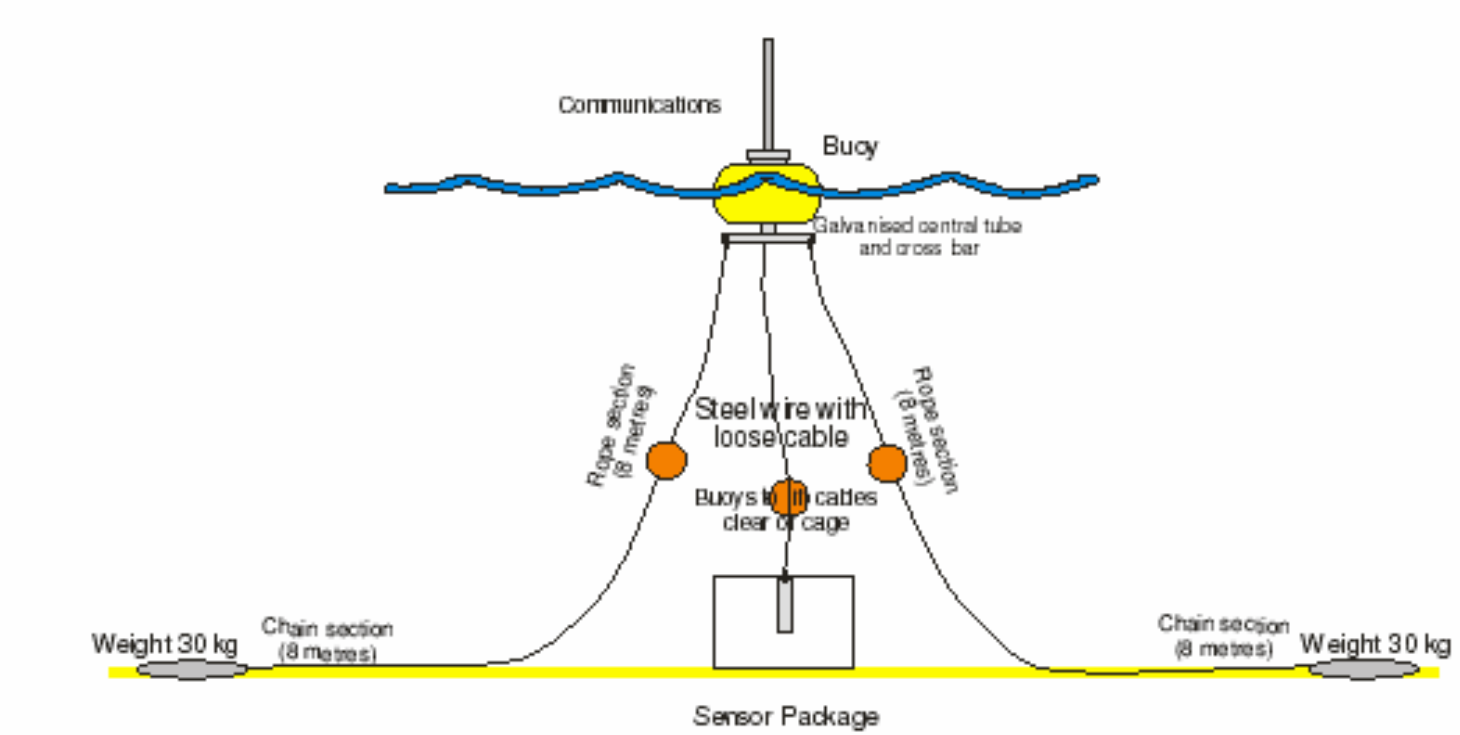
SECOAS aims

- Model the coastal environment
  - understand and be able to predict movement of sandbanks and coastal erosion for coastal town planning and risk assessment of developments, including offshore windfarms
  - derive probabilities of flood events (convergence of high tides, gales, strong currents) to determine appropriate size and position of flood defences
- Gain information on current coastal conditions
  - aid risk assessment for putting to sea for safety of vessels
  - generate warnings for local inhabitants when flood conditions arise for timely evacuation or safeguarding of property

SECOAS Sensor Module Design



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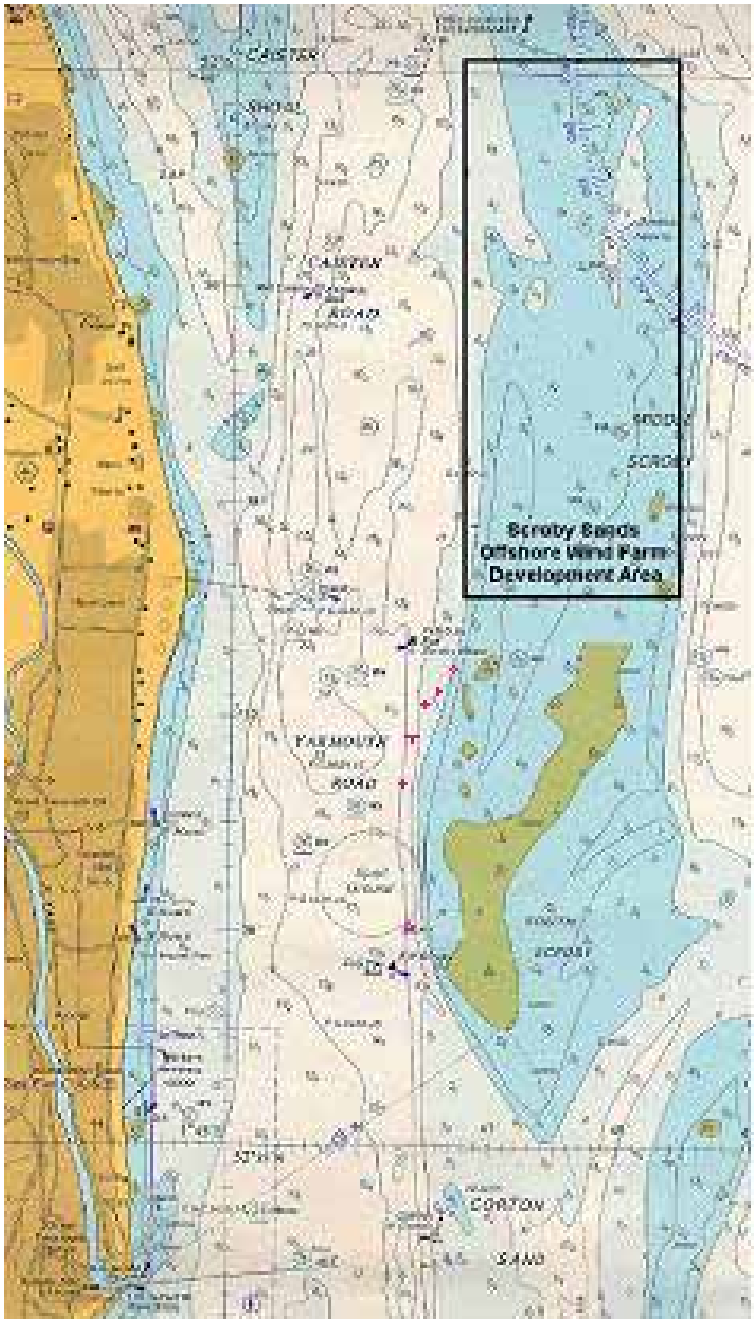
Environmental Sensing

Scroby Sands Wind Farm, UK

- Provision of a wireless sensor network in outdoor or indoor environments.
- Use of a data compression and management system to summarise complex multi-dimensional time series data and forward it to repositories in a power efficient way
- Provision of an in-situ data handling system
- Implementation of auditing systems that match regulatory obligations with actual performance



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SECOAS Technology Dividend

- Potential for advanced flood warning.
- Coastal defence planning.
- Understanding impact of coastal developments, such as windfarms.
- Input into national and global models of climate change.